THE MALAWI NATIONAL EXAMINATIONS BOARD

2024 MALAWI SCHOOL CERTIFICATE OF EDUCATION EXAMINATION

CHIEF EXAMINER'S REPORT

CHEMISTRY (M038/I & II)

General Comments on:

A. Quality of the paper

Paper I

The 2024 Chemistry Paper I was relatively fair. It compared well with last year's paper in terms of language and level of difficulty. It had no typographical errors. Rubric, the scoring guide and font size were good. The paper adequately covered all the core elements in the syllabus. It was a valid paper as it examined a wide range of scientific skills such as manipulation of figures, explanations, naming, defining concepts, descriptive questions, drawing structures and designing experiments.

The level of language used was appropriate for the candidates; questions were clear and could not confuse the candidates. The level of difficulty of the paper was appropriate as the question items covered all the levels of Bloom's.

Paper II

The 2024 Chemistry Paper II examination was relatively fair in terms of difficulty of the test items. The paper compared well with previous Chemistry II papers. The language used was appropriate to the level of MSCE candidates. The test items were drawn from various areas of the syllabus and measured a variety of knowledge and skills such as data observation, measuring instruments reading, data recording, data interpretation, reasoning, drawing relevant conclusions, numerical, drawing, designing/describing an experiment.

B. Performance of Candidates

Paper I

The candidates' performance in Paper I was average. The highest score was 93 and lowest score was zero. Number of zeros has drastically decreased this year compared to last year.

Most candidates performance was affected mainly due to failure to draw correct structures, interpreting data in tables, manipulation of figures up to the point of coming up with correct response with correct units, failure to complete a chemical equation by identifying correct products and writing correct chemical formula, failure to name a given part of a diagram and failure to draw a valid conclusion of an experiment.

In some questions, candidates wrote completely different responses from what they were examined on, which showed lack of mastery of content and inadequate coverage of syllabus in schools.

Paper II

The overall performance of candidates in Paper II was average and better than last year. More than 60% of candidates scored between 18 and 26 out of 40 marks. Some candidates scored 40 out of 40 marks (about 19) this year compared to fewer last year. In addition, there is a decrease in number candidates scoring zeroes this year (7). All these indicate an improvement in candidates' performance. The improvement in the performance can be attributed to availability of Chemistry textbooks in Secondary schools through EQUALS projects and qualified Chemistry teachers even in community day secondary schools in remote areas. **C. Comments on Performance of Candidates on Individual Questions**

PAPER I

Section A

Question 1 a (i)

The question asked candidates to name the labelled parts A and B in a given diagram of a paper chromatography. It was popular, most candidates attempted it but most of them failed. Instead of naming they were explaining. Others were unfamiliar with the diagram as

such their funny responses were: naming parts of an atom, energy levels, protons and electrons, parts of the earth's lithosphere, xylem, and phloem. For part A, other candidates could just write solvent instead of solvent front. Part B were rings of dye.

Question 1 a (ii)

Candidates were asked to choose which dye had a higher rate of movement between X and Y. It was popular, most candidates' response was correct; those who failed were talking about A or B instead of X and Y. The correct response was Y.

Question 1 b

Candidates were asked to give another way of determining purity of a substance apart from using paper chromatography. The question was popular, most candidates' response was correct. Other candidates could just write melting method or boiling method instead of melting point or boiling point.

Question 2 a (i)

The question asked candidates to define the term mole. It was popular; most candidates' response was correct. Other candidates failed to write Avogadro's number and wrote it as 6.023×10^{-23}, 6.23×10^{23}, 0.623^{23} instead of 6.023×10^{23}

Question 2 a (ii)

Candidates were asked to calculate number of moles in $5.6dm^3$ of carbon dioxide at s.t.p. It was popular and most candidates' response was correct. Most solved without writing a formula. Other candidates wrote wrong units for example, g or $dm^{3.}$ The correct calculation was $5.6/22.4 = 0.25$ moles.

Question 2 b (i)

Candidates were asked to state the difference between a strong acid and a weak acid. The question was popular and most candidates' response was correct. Other candidates were only writing of one side. In comparison, candidates were supposed to talk about both sides. The correct response is: a strong acid dissociates completely while a weak acid dissociates partially in water.

Question 2 b (ii)

Candidates were asked to identify any one conjugate acid-base pair from a given equation. Most candidates did well. Other candidates failed to write the standard way of writing conjugate acid- base pair by writing a slash in between them. The correct response was: CH_3COO^-/CH_3COOH or HCN/CN^-

Question 3 a

Candidates were asked to justify the reason for common salt dissolving in water but not in cooking oil. Most candidates failed to write polarity of water and attraction of salt ions to polar ends of water.

Question 3 b

Candidates were asked to give any two raw materials used when preparing nitric acid in the laboratory. Most candidates failed. The correct raw materials are ammonia and oxygen. Some were listing the apparatus e.g. round bottom flask.

Question 4 Candidates were provided with general formulae of some organic compounds.

Question 4 a

The question asked candidates to name families of compounds A (alkanoate) and B (alkanone). It was popular but most candidates failed part A, they were writing alkanoic acid because of COO. They failed to identify R as a radical. Funny responses included nuclear family, extended family, others groups of periodic table.

Question 4 b

Candidates were asked to write a molecular formula of compound C with four carbon atoms. It was popular but most candidates failed. Most were substituting, n = 4 instead of 3 since the other carbon is in the functional group. Other candidates wrote a condensed formula instead of molecular formula. The correct formula is C_3H_7CHO.

Question 4 c

Candidates were asked to draw the structure of compound A with four carbon atoms. It was popular but most candidates' response was incorrect. Those who failed were drawing the structure of carboxylic acid instead of that of an alkanoate.

Question 4 d

Candidates were asked to state any one chemical property of a member from homologous series C. It was popular and most candidates' response was correct. Some candidates who failed were writing uses of C, physical properties and how it is formed. The correct responses include: undergoes combustion, reacts with water, and undergoes addition reactions.

Question 5 a (i)

Candidates were asked to define reduction in terms of oxidation number. It was popular and most candidates' response was correct. Other candidates defined in terms of oxygen content, others in terms of gaining of electrons. The correct definition is: decrease in oxidation number.

Question 5 a (ii)

Candidates were asked to calculate the oxidation number of Chromium in a given formula ($Cr_2O_7^{2-}$). It was popular and most candidates did well. Those who lost marks did not include charge on oxidation number i.e. +6. Others failed to make Cr the subject of the formula instead wrote $Cr_2 = +12$

Question 5 b

Candidates were asked to explain how magnesium hydroxide solution is used to treat stomach upsets. It was popular but most candidates were not able to get all the marks. They failed to recognise magnesium hydroxide as a base that would neutralise excess acids in the stomach. Funny answers included: magnesium kills germs (bacteria) in the stomach; magnesium contains acid which kills bacteria.

Question 5 c

Candidates were asked to calculate the relative formula mass of copper hydroxide [$Cu(OH)_2$]. It was popular, most candidates' response was correct. Those who failed wrote RFM with units; however, RFM has no units. The correct answer is 98.

Question 6 a

Candidates were asked to state any one application of precipitation reactions. Most candidates' response was correct. One of the funny responses was formation of rain. The correct answers included: treatment of water for domestic use, treating effluents in industries.

Question 6 b Candidates were provided with a diagram of an electrochemical cell.

Question 6 b (i)

Candidates were asked to name part labelled X (salt bridge) on the diagram. It was popular but fewer candidates' response was correct. Those who failed wrote: salt, bridge, tube, delivery tube, beit bridge, bridging salt.

Question 6 b (ii)

Candidates were asked to state two functions of part labelled X (salt bridge). It was popular but most candidates' responses were incorrect. Funny responses included, go between. The correct answer is to complete the circuit by allowing ions to move from one cell to the other. It also provides positive ions to replace those used up at the electrodes.

Question 6 b (iii)

Candidates were asked to write half equations at the anode and cathode. It was popular but most candidates' response was incorrect. Most failed to identify where reduction and oxidation take place. Some candidates who failed wrote Mg – 2e Mg +2 or Mg 2+ + 2e Mg. Funny responses were p -type, n-type. Others did not write charge at all. The correct responses are:

Anode: $Mg(s) \longrightarrow Mg^{2+}(aq) + 2e^-$

Cathode: $Cu^{2+}(aq) + 2e^- \longrightarrow Cu(s)$

Question 7 a

Candidates were asked to give any one property of thermosetting plastics. It was popular, most candidates' response was correct. Those who failed were writing properties of thermo-softening plastics. The correct response included: they can easily be remoulded, they easily soften when heated.

Question 7 b

Candidates were asked to draw the physical structure of propyl ethanoate. It was popular but most candidates' response was incorrect. Most failed to draw correct position of an alkanol and alkanoic acid. Funny response were drawing cross links of thermosetting plastics.

Question 7 c

Candidates were tasked to complete a given chemical equation. It was popular but most candidates' responses were incorrect. Most failed on the part of writing the correct formula of (CH_3COO). The correct equation was:

$MgCO_3 + 2CH_3COOH \longrightarrow (CH_3COO)_2Mg + CO_2 + H_2O$

Question 8 a (i)

The question asked candidates to give any two examples of greenhouse gases. It was popular, most candidates' responses were correct. Wrong responses were: house for grasshoppers, goats, oxygen dioxide. The correct gases included: carbon dioxide, sulphur dioxide, methane, nitrogen dioxide.

Question 8 a (ii)

Candidates were asked to justify how greenhouse gases cause acid rain. It was popular; most candidates' response was correct. However, those that failed wrote the formation of an acid when a greenhouse gas react with rain water. Wrong responses included reaction of greenhouse gas with clouds, greenhouse gas flies in the air, greenhouse gases destroy ozone layer then forming acidic rain.

Question 8 b

Candidates were asked to state any two ways through which ozone layer depletion could be controlled. It was popular but most candidates' response was incorrect. They wrote about global warming instead of ozone layer. Wrong responses were: avoid burning of tyres, afforestation and reafforestation, avoid use of cars that release carbon dioxide, avoid cutting down trees. The correct responses included: use of CFC free aerosol sprays, recycling empty aerosol containers.

Question 9 a

Candidates were asked to give any two natural sources of alkanoic acids. It was popular, most candidates' response was correct. Wrong responses were banana peels, bees or ants without writing sting, fruits or acetic fruits, DNA. The correct responses were: citrus fruits, grapes, vinegar, tea.

Question 9 b Candidates were provided with a table showing melting and boiling points of some carboxylic acids.

Question 9 b (i)

Candidates were asked to explain the trend in boiling points going down the table. It was popular, but most candidates failed to mention about the need of more energy to break. Some wrong responses were on electron affinity, atomic radius, hydrogen bonding. The correct response was: As you go down boiling points increase because of the increase in molecular size which increases the IMF as a result it requires more energy to weaken.

Question 9 b (ii)

Candidates were asked to explain why the melting point of butanoic acid is lower than that of methanoic acid. It was popular but most candidates' response was incorrect. They failed to mention the hydrogen bonding in OH i.e. decreasing it's forces when going down.

Question 10 a

Candidates were asked to define recycling. It was popular and most candidates' response was correct. Those who failed were defining re- using. Others were repeating the term recycling in definition. The correct definition was: reprocessing of a material that would be considered waste OR the process of converting a waste into a new useful product.

Question 10 b

Candidates were asked to name two waste materials that could be recycled. It was popular and most candidates' responses were correct but those who failed were just writing examples of plastics i e plastic cup, plastics shoes. Funny responses included plastic wood.

Question 10 c

The question asked candidates to outline three steps that could be followed in recycling old used papers into new papers. It was popular but many candidates failed. Correct response was: Soak old used papers into water for three days; transfer the soaked paper into mortar and grind them with a pestle; sieve, spread them and mould into new paper. Wrong responses were, collecting, sorting and cleaning.

Question 10 d

Candidates were asked to state any two problems associated with the depletion of ozone layer. It was popular, most candidates' response was correct. Those who failed were writing global warming, drought, climate change, melting of ice in polar regions, death, high temperatures instead of causing skin cancer, damage to crops, causes cataracts..

Section B

Question 11 a

Candidates were asked to describe an experiment that could be conducted to determine the strength of an acid using pH. It was popular and most candidates' response was correct. Other candidates failed to write the right indicator which is universal indicator instead they wrote phenolphthalein indicator, litmus paper. Some candidates wrote using ammeter, voltmeter like electrical conductivity test. Others were writing on how to measure acidity

of the soil. Many failed to draw a valid conclusion i.e. correct range of strong acid and weak acid on pH scale. Others were talking about concentration instead of strength of acid. Funny responses were pour the acids in pH meter or pH scale

Question 11 b

Candidates were asked to explain the effect of temperature on the rate of a chemical reaction. It was popular, most candidates' response was correct. Others failed to explain the reason why increase in temperature causes increase in rate of a chemical reaction. Some candidates instead of explaining the effect were describing an experiment. The correct response was: as the temperature is decreasing, the particles lose their kinetic energy and start moving slowly. This causes the particles to make few fruitful collisions per unit time therefore the rate of reaction decreases. When temperature increases, the opposite is true.

Question 12 a

Candidates were asked to describe how sugar and common salt could be used to compare the strength of electrostatic forces in covalent and ionic compounds. It was popular but most candidates' response was incorrect. Those who failed were explaining on electrical conductivity, solubility of the two in water instead of heating and take note of time they melt and relate to strength of electrostatic forces of attraction. Wrong response was grinding both sugar and salt and bring a charged material closer.

Question 12 b

With the aid of a chemical equation, candidates were asked to describe the preparation of ammonia using the Harber cycle. It was popular and most candidates' response was correct. Those who failed could not write correct chemical equation, could not mention the correct catalyst, i.e. wrote vanadium, rhodium. Others could not conclude that unreacted materials are put back in reaction chamber. Other candidates stated by explaining how nitrogen and hydrogen are obtained which was not necessary.

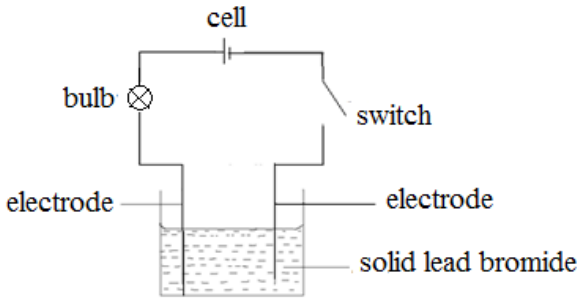
Question 13

Candidates were asked to construct a flow diagram that could be used to identify the given organic compounds. It was popular and most candidates' response was correct. Those who failed could not write correct observations of the tests i.e. positive result or negative result. Some were using letters, A B, C and D without a key. Other candidates were writing tests that were not given. Others, instead of using compounds given, were writing family name.

PAPER II

Question 1

Question 1 was popular as it was attempted by many candidates. In the question, the candidates were asked to use a well-labelled diagram to describe an experiment that could be conducted to show that molten lead bromide conducts electricity while solid lead bromide does not. Majority of the candidates demonstrated mastery of the content by scoring 5 or more out of 10 marks. They drew a diagram of conductivity apparatus as follows;



Then the solid lead bromide was supposed to be heated to make it molten. The bulb in set up using molten lead bromide would have given off light because it has free ions while in solid lead bromide would not. Some candidates missed marks for drawing a wrong diagram due to a wrong electrical symbols or omission of cells or without electrodes or labels. Some candidates thought that adding water to lead bromide will make it molten. Many candidates who failed answered the question in terms of electrolysis of molten lead bromide and focused on what is happening at electrodes.

Question 2

Candidates were asked to describe the preparation of ethyl ethanoate with an aid of an equation. The question was not popular and performance by most candidates was poor. The few candidates who demonstrated mastery were able to deduce reactants as ethanol and ethanoic acid. These reactants were supposed to be mixed in a beaker in hot water bath and add sulphuric acid for the reactants to react as follows $C_2H_5OH + CH_3COOH \longrightarrow CH_3COOC_2H_5 + H_2O$. Water is then added to dissolve unreacted reactants.

Majority of the candidates missed the question completely and described preparation of either ethanol or ethanoic acid. Some candidates missed several steps and went straight to the equation. Furthermore, candidates lost marks for not being specific with reactants (e.g. alkanol and alkanoic acid) and wrong catalyst (e.g. HCl, acetic acid, potassium permanganate). Marks were also lost for indicating that the mixture is boiled instead of heated. This misconception was very common as many candidates wrote 'boil the mixture of ethanol and ethanoic acid'. In many cases candidates failed to write correct molecular formulae of reactants and products in the equation, mainly that of ethyl ethanoate. This poor performance reveals that the concept of preparation of ethyl ethanoate is not adequately covered across all schools.

Question 3

In this hands-on question, candidates were required to carry out a titration experiment using 0.1 M hydrochloric (HCl) acid solution and sodium hydroxide (NaOH) solution of unknown concentration. The data obtained was supposed to be used to calculate the concentration of NaOH solution. The performance of the candidates was below average as majority scored below 5 out 10 marks. Clearly many schools used syringes in the experiment which are not accurate as burettes in measuring volume of liquids.

Question 3 a to i

In part **a** to **i** candidates were supposed to obtain the following results in **Table 1.**

Table 1

Volume of HCl (cm^3)	1st Run	2nd Run
Initial volume	0 or 25 or 50	0 or 25 or 50
Final volume	15 or 10 or 35	15 or 10 or 35
Volume of HCl	15	15

Candidates lost marks for not obtaining values within a range of $\pm$ 1 due to poor reading of burette and lack of knowledge on how to use syringes. In some cases, candidates were subtracting final volume from initial volume hence ended up with negative value such as –15 ml.

Question 3 j

The question asked candidates to calculate average volume of the HCl solution used. The average volume was supposed to be found by adding the volumes of HCl used in 1st and 2nd runs and divide by 2 i.e. $\frac{15+15}{2}$ = 15 cm^3. Majority failed this question because they either used wrong values obtained above or simply added the two values without dividing by 2.

Question 3 k

In this question candidates were demanded to write a balanced equation for the reaction between NaOH and HCl. The question was popular and majority of the candidates wrote the equation correctly as:

$NaOH + HCl \longrightarrow NaCl + H_2O$. A few candidates lost marks for not balancing the equation or wrote wrong chemical formulae for the products eg NaCL, $NaCl_2$, HO_2. Likewise, some candidates simply listed the products and reactants as follows; $NaOHHClNaClH_2O$, without using + or $\longrightarrow$ signs.

Question 3 l

The question required candidates to calculate the concentration of NaOH solution. The correct response was to use the formula: $C_b = C_aV_an_b/V_bn_a$ and those who got it right managed to get 0.1 M as concentration of NaOH solution. Majority of the candidates who failed only managed to write the equation correctly but missed on the answer due to wrong substitution in the equation.

Question 4

In this question, candidates were asked to conduct an experiment in order to investigate which unknown solutions labelled **P**, **Q**, **R** and **S** contain water using anhydrous copper sulphate. The question was very popular and most candidates' performance was outstanding.

Question 4 a to d

In this part, majority of the candidates recorded the following correct observation in **Table 2**:

Table 2

Solution added to anhydrous copper sulphate	Colour change
P	Blue
Q	White/grey/no colour change
R	White/grey/no colour change
S	Blue

Based on interactions with answers, solution **Q** seemed not to have been prepared accordingly in many schools.

Question 4 e

This part asked candidates to classify solutions into those that contain water and those that do not contain water. The solutions that contained water were **P** and **Q** while solutions that did not contain water were **Q** and **R.** A few candidates failed this question by indicating colours instead of letters **P**, **Q**, **R** and **S**. Some candidates wrote aqueous or hydrated or polar or soluble compounds as the solutions that contained water in the experiment. In some cases, candidates named the solutions using names such as sodium hydroxide, ethanoic acid and hexane.

Question 4 f

Candidates were asked to explain the answer in **4 (e).** This question was attempted by many but the performance was poor. The few candidates who got this question correct wrote that water turns white anhydrous copper sulphate to blue. Many candidates failed the question for simply stating that **P** and **S** turned blue while **Q** and **R** remained white. Further to that, some candidates explained in terms of presence of –OH, solubility and polarity.

Question 4 g

This part asked the candidates what other substance could have been used in this experiment apart from anhydrous copper sulphate. The substance was anhydrous cobalt chloride. Those who failed responded like hydrous cobalt chloride, hydrous copper sulphate, lead cobalt, anhydrous cobalt chloride, sulphuric acid.

Recommendations to:

(i) Schools

Schools should:

- adequately cover the syllabus.
- assess students and given more time for practice
- buy science materials and make them available for teachers to conduct experiments during delivery of lessons.
- encourage teachers to practice with students how to handle descriptive questions and how to draw valid conclusions from experiments
- encourage teachers to participate in planned INSET and implement skills learnt

- encourage continuous assessment in practical lessons.
- encourage teachers must be encouraged to read and understand Chief Examiner's reports.

(ii) Ministry of Education

The Ministry should:

- train and employ more Chemistry teachers that are lacking in Schools
- provide laboratory materials and apparatus
- sustain CPDs/INSETs such as EQUALS and SMASSE to equip unqualified teachers with necessary knowledge, skills and expertise.